The Challenges Facing Shatt Al Arab River in Present and Future

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Abstract

Shatt Al-Arab River is regarded as one of the most important rivers in Iraq and the main source of surface water in Basra governorate. Its water is used for various purposes; drinking, irrigation, fisheries, navigation, and industry. Shatt Al-Arab River forms at Qurna where the Tigris and Euphrates Rivers join together, it's a conjunction link of freshwater from Iraq into the Arabian Gulf.

This river has been subjected to increase salt concentration; the principal reason for this is local and regional factors. The former is due to water pollution. The latter is the low-level discharge from Tigris and Euphrates. The high salt level in Shatt al-Arab is a threatening environmental disaster.

In this paper, factors that participate in the present-day state of Shatt Al-Arab to change the physical properties of its water have been studied by analyzing the effect of natural and anthropogenic variations of main sources and by analyzing data observation of salt in Shatt Al-Arab and water discharge in Kassarah Dam, with focusing on the future challenges expected for Euphrates and Tigris rivers and their effects on Shatt Al-Arab, mostly based on a literature review of recent foreign publications on the problem.

The results show a significant increase in salinity over time from upstream to downstream of Shatt Al-Arab, resulting in a decline in quantity and quality of freshwater, and as long as the sources of Shatt Al-Arab go on water shortage or dry up; water of Shatt Al-Arab will turn into seawater coming from the Arabian Gulf with the tidal wave.

Keywords: watersheds, future challenges, salinization, freshwater, ecosystems.

Introduction

Shatt Al-Arab River (SAR) is regarded as one of the most important main rivers in Iraq and the main source of surface water in Basra governorate; its water is used for various purposes; drinking, irrigation, fisheries, navigation, and industry.

The SAR is a 195-km-long tidal river flowing south-eastwards, passing along the city of Basra, then the Iraqi port of Abo Flus and the Iranian port of Abadan, subsequently the city of Faw and from there, a final 18-km stretch where it discharges into the Arabian Gulf (also called the Persian Gulf, hereafter referred to as the Gulf).[1]

SAR originates from the confluence of two large Asian rivers Euphrates and Tigris, and, in essence, is the mouth part of the channel system of these rivers. Moreover, SAR is an independent mouth hydrographic feature, which occupies an intermediate position between the Euphrates and Tigris river systems, on the one hand, and the Gulf of the Indian Ocean, on the other hand [2]. SAR also receives small streams from Sweeb River, which brings its water from the Hawizeh marshes, shared between Iraq and Iran (fig.1); its water sources from Karkheh and Tigris Rivers. The last SAR source is the Karun River, which can be considered a shared basin because it discharges into the SAR, which forms the Iran-Iraq border [3]. Thus, the SAR receives waters originating from the indicated rivers' watersheds located in Turkey, Syria, Iran, and Iraq. The river also serves as a boundary between Iraq and Iran 8 km upstream of the Karun River's inlet through to the SAR estuary. [1]

SAR forms the main source of freshwater for the Arabian Gulf and plays an important role in marine habitats in the Gulf's north-eastern coastal areas. However, the large-scale development of upstream water regulation and dam structures and the drainage of the Mesopotamian Marshes have caused severe salinization of the river. This threatens marine ecosystems in the Gulf and jeopardizes agricultural activity along with the Shatt Al Arab.[3]

This paper aims to study all factors that participate in the present-day state of the SAR to change the physical properties of its water by analyzing data observation of salt in SAR and water discharge in Kassarah Dam. Besides, analyze the effect of natural and anthropogenic variations of main sources and focus on the future challenges expected for Euphrates and Tigris rivers and their effects on SAR mostly based on a literature review of recent foreign publications on the problem.

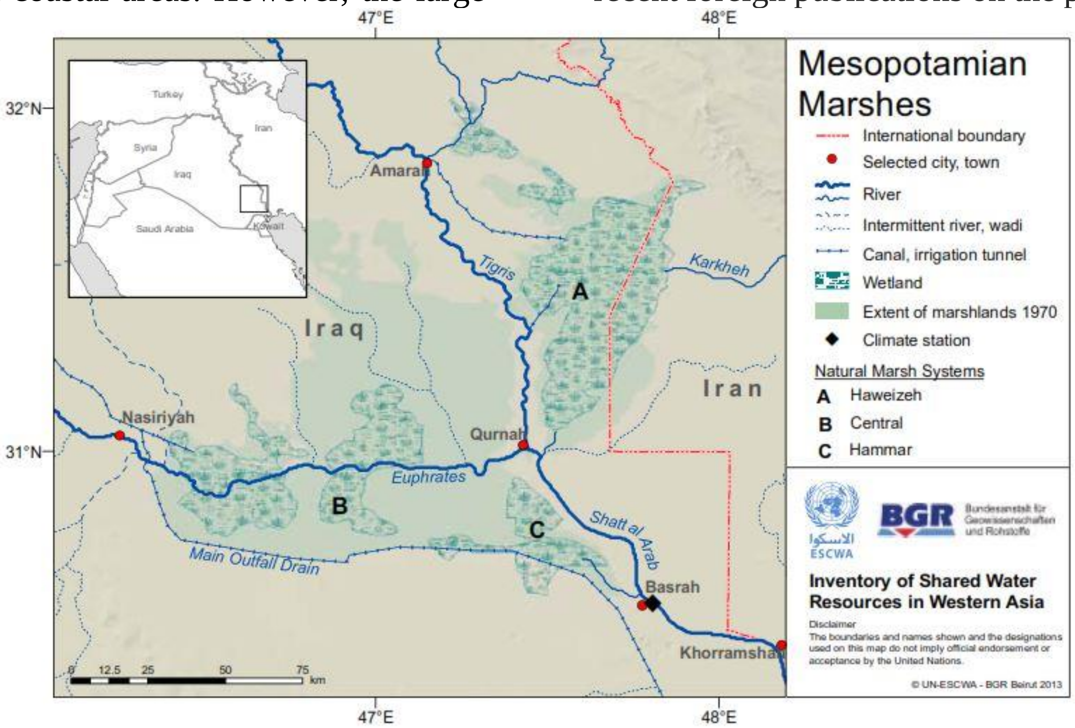


Fig (1) Mesopotamian marshes [3]

Geographical and Hydrological Characteristics of SAR Sources:

Euphrates River is the longest river in Western Asia. The river has three riparians' countries, Iraq, Syria, and Turkey, and its basin is distributed among five countries. Most of the Euphrates stream-flow originates from precipitation in the Armenian Highlands; contributions by the remaining riparian countries are generally small. In addition to some intermittent streams, the Sajur, Balikh and Khabour are the main contributors to Euphrates flow in Syria.[3] Figure (2), with a wide and slow stream, the river crosses the Syrian-Iraqi border at Qaim. Downstream, the river flows through the Jazirah plateau, a limestone desert. The river then loses its water into a series of braided channels, some of which flow into the Hammar marsh (Grego et al. 2004). However, it also receives water from the Tigris River through a canal from the Tharthar Lake constructed to supplement the decreasing flows in the Euphrates due to upstream developments.[1]

In their lower reaches, the Euphrates and Tigris flow over the Mesopotamian Lowland, which the sediments of these rivers have formed. The slope of the water surface here average $4x10^{-5}$ and $8x10^{-5,}$ respectively [19][2].

Euphrates River travels further south, joining the Tigris River at Qurna

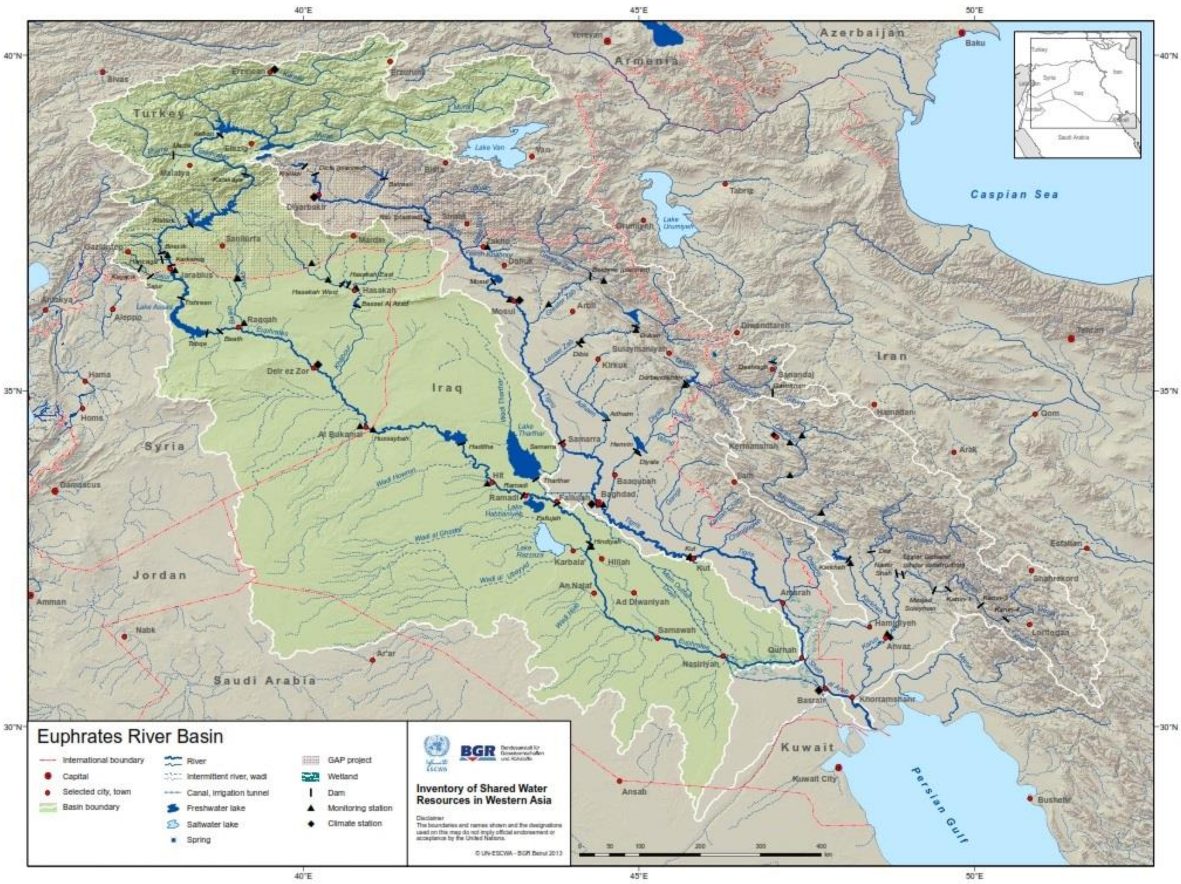


Fig.(2) Euphrates and Tigris Rivers Basin [3]

Roughly 75–80 percent of the Euphrates' water is used in agriculture in Turkey, Syria, and Iraq. As irrigation has expanded and new dams have been added, Turkey's water volume flowing through Syria to Iraq has dropped. Since Turkish and Syrian dams came into operation in the 1970s, the flow into Iraq has dropped dramatically from 700 cubic meters per second (m^3/s) to the current level of 260 m^3/s [22]. Figure (3) compares the average-flow hydrograph of the Euphrates before and after modern exploitation projects.[4]

The Euphrates River's mean daily discharge at Hit and Haditha cities has dropped from 967m^3/s (before 1972) to 553 m/s (after1985). The percentage decrease in river discharge is 43% fig.(4)[5]

Tigris River is the second-largest river in western Asia, it has its springs in the Taurus Mountains in Turkey, about 30 km from the upper catchment of the Euphrates. The tributaries Batman, Garzan and Bokhtanchai contribute most of the Tigris' water in the upper reach (Italy- Iraq 2006). The river flows south-east and forms the Turkish-Syrian border (approximately 37 km) and the Syrian- Iraqi border (approximately 7 km) (Kliot 1994).[1] crosses the north Iraqi border at Faish Khabur village, located about 400 km from the main sources [6], and flows for 1418 km inside Iraq (77% for the total length of the river).

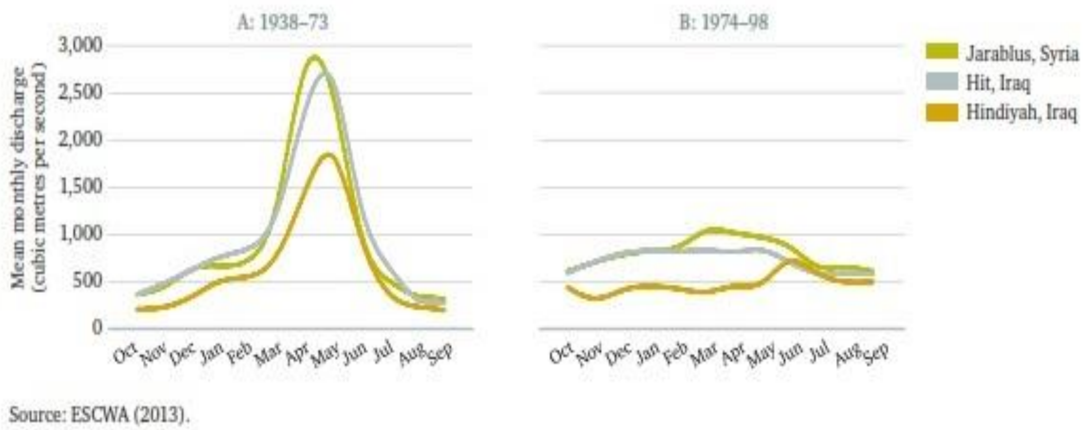


Fig.(3) show the comparison of the Euphrates' flow before and after modern exploitation projects [4]

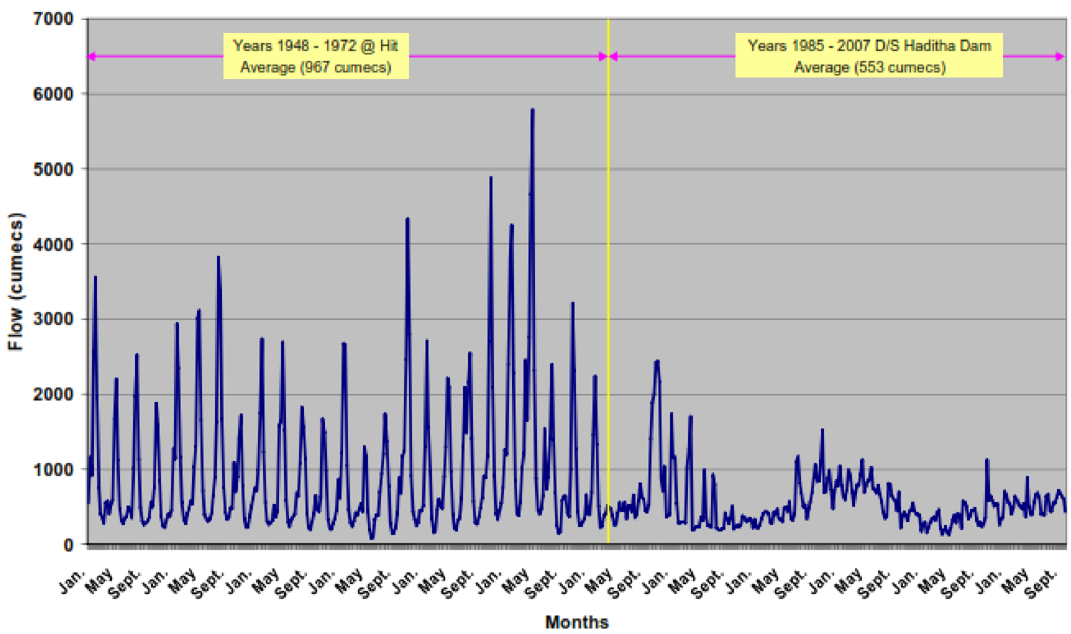


Fig. (4) Average monthly recorded discharges of Euphrates River at Hit and Haditha stations for the period 1948-2007 [8]

It has five tributaries inside Iraq (Al-Khabour, Upper Zab, Lower Zab, AlUdhaim, and Diyala). The total catchment areas are shared by Turkey, Syria, Iraq and Iran [7],[8].[5]

Further downstream, at Missan, the river divides into five main branches and a series of canals. Four of the main branches eventually lose their water into the marshes while the principal channel travels further south, joining the Euphrates at Qurna. Part of the marsh's water returns to the Tigris on its right bank through several small canals and mainly the Kassarah River, north of Qurna [1]. Tigris River mean discharge at Mosul city before 1984 was

701m/s and dropped to596 m3/s afterward. This implies a 15% decrease in the river discharge Fig.(5) [5].

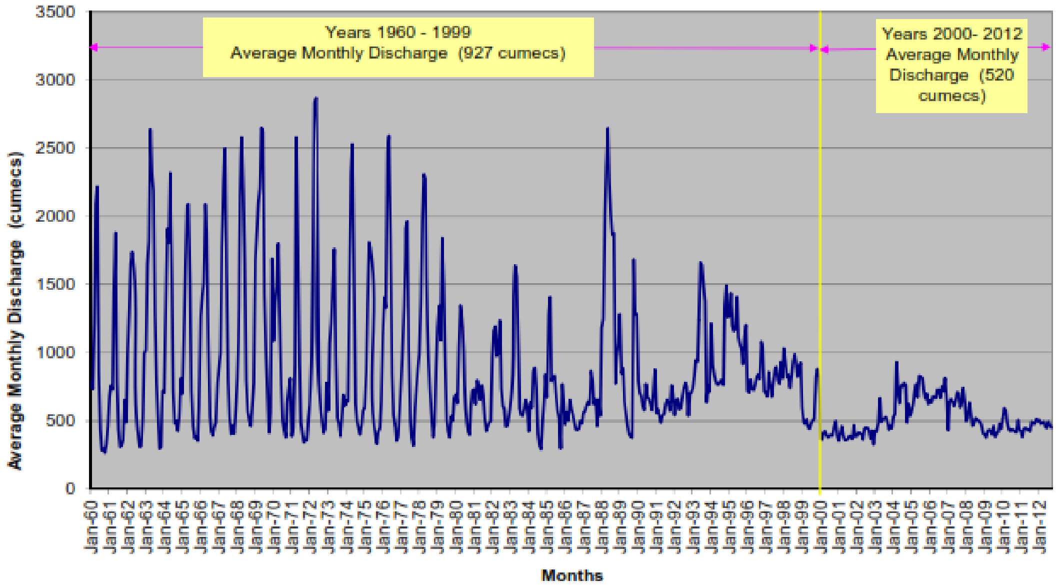


Fig.(5) Average Monthly Discharge of Tigris River at Sarai Baghdad Station[8]

The Karkheh River Basin is located in southwest Iran, between 30^0_58′– 34^0_56′ N latitude and 46^0_06′– 49^0_10′ E longitude. The area is about 50 700 km^2, with considerable variation in elevation, from a minimum of 3m above sea level in the south (Dasht Azadeghan) to a maximum of 3645m in the Karin Mountains in the north.[9]. Its discharge flows into the transboundary Hawizeh marshes that straddle the Iraqi and Iranian border [10],[11]. The major river regulation started in 2001 with the construction of the large and multipurpose Karkheh dam. The water allocations are expected to increase to 8.6×10^9 m^3/yr in 2016 due to investment in various dams and irrigation schemes currently under construction or in the planning phase (Italy-Iraq 2006, Masih et al. 2011). The Karkheh River contributes about 6.3 × 109 m^3/yr to the Hawizeh marsh under natural flow conditions (Grego et al. 2004). However, the water flow to the marshes has been altered after the dams' construction, and the discharge may be as low as zero in the future with the accomplishment of upstream developments.[1]

The Karun River is among the most important watercourses of Iran, with the largest discharge and is the only navigable waterway. Similar to the Karkheh River, it originates in the Zagros Mountains of western Iran. The river joins the SAR 87 km upstream of the mouth. The Karun River drains about 63,000 km2, which lies wholly in Iran (Italy-Iraq2006). The Karun has an average discharge of 24.7×10^9 m^3/yr (Grego et al. 2004). The amount of freshwater supplied by the Karun River to the SAR holds significant importance in reducing seawater intrusion.[12] All these rivers and Arabian Gulf contribute and form the water quality of SAR

Factors cause the problem to Iraqi water sources

The main factors that cause a problem for the main water resources in Iraq are divided into two types: Human interference, population, agriculture, infrastructure and dams. The **Second** are the natural factors which are summarized as climate change.

First: As the population of the region progressively increases, the demand for agricultural products increases and as a result, the number of water supply projects also increases. In 1973, Turkey constructed the Keban Dam in the Euphrates River Basin; the Syrian Tabqa Dam was built and filled in 1975. The filling of these dams caused a sharp decrease in downstream flow and the quantity of water entering Iraq fell by 25 % [13]. In 1977, Turkey announced plans for the region's largest water development project ever, the Southeastern Anatolia Project (GAP), which included 22 dams and 19 hydropower projects built on the Euphrates–Tigris. The Ataturk Dam construction in Turkey, one of the GAP projects, was completed in 1992. Table (1) shows the large dams in the Euphrates–Tigris River Basin.[14]. The overall volume of water to be captured is about 100 $km^{3,}$ three times more than the overall capacity of Iraqi and Syrian reservoirs [15]. In addition to the GAP dams, Syria built three major dams with a total storage capacity of 16.1 km^3 Table (2). When GAP project is completed, 80% of the Euphrates water will be controlled by Turkey [58-60]. Syria used to receive 21 km^3/year of the Euphrates water before 1990, which dropped to 12 km^3 from 2000 onwards (40% reduction) [12].

As far as Iraq is concerned, the volume of the water received dropped from 29 km^3 before 1990 [15] to 4 km^3 (90% reduction)[12]. The Ilısu Dam is also expected to reduce the flow of the Tigris into Syria and Iraq.[16] When the Dam reaches its final stages, and huge volumes of water are retained, it cuts Tigris River's levels to its half and reduces its quality.[17] Turkey can exert virtual control over the Tigris and Euphrates Rivers' water is of vital concern to Iraq, which depends on these two rivers for much of its water supply. [15]

Turkey's use of water has so far been limited mainly to hydropower generation and irrigation. While the former use is considered non-consumptive and not directly linked to water quality, the return flow from irrigation causes water pollution, affecting potential downstream uses. Water quality degrades downstream, with major pollution inflows from urban areas such as Baghdad due to poor wastewater treatment infrastructure [14]. The quality of the water in Euphrates and Tigris is further degraded by return flows from land irrigated in Iraq as well as urban pollution. The deterioration of water quality and the heavy pollution from many sources are becoming serious threats to SAR.

Table (1) Large Dams in the Euphrates-Tigris River Basin [14]

Country	Name	Nearest city	River	Year	Height (m)	Capacity (million m³)	Main use *
Turkey							
	Keban	Elazig	Firat	1975	210	31 000	H, F
	Karakaya	Diyarbakir	Firat	1987	173	9 580	H
	Ataturk	Sanliurfa	Firat	1992	169	48 700	I, H
	Ozluce	Bingol	Peri	2000	144	1 075	H
	Kralkizi	Diyarbakir	Maden	1997	126	1 919	H
	Kuzgun	Erzurum	SerCeme	1996	110	312	I, H
	Dicle	Diyarbakir	Dicle	1997	87	595	I, H, W
	Batman	Batman	Batman	1999	85	1 175	I, H, F
	Erzincan	Erzincan	Goyne	1997	81	8	I
	Zernek	Van	Hosap	1988	80	104	I, H
	Kockopru	Van	Zilan	1992	74	86	I, H, F
	Kayalikoy	Kirklareli	Kaya	1986	72	150	I
	Demirdoven	Erzurum	Timar	1996	67	34	I
	Tercan	Erzincan	Tuzla	1988	65	178	I, H
	Birecik	Sanliurfa	Firat	2000	63	1 220	I, H
	Sarimehmet	Van	Karasu	1991	62	134	I
	Sultansuyu	Malatya	Sultansuyu	1992	60	53	I
	Mursal	Sivas	Nih	1992	59	15	I, H
	Surgu	Malatya	Surgu	1969	55	71	I
	Polat	Malatya	Findik	1990	54	12	I
	Goksu	Diyarbakir	Goksu	1991	52	62	I
	Kayacik	Karaburun		2002	50	117	I
	Hancagiz	Gaziantep	Nizip	1989	45	100	I
	Camgazi	Adiyaman	Doyran	1999	45	56	I
	Medik	Malatya	Tohma	1975	43	22	I
	Hacihidir	sanliurfa	sehir	1989	42	68	I
	K. Kalecik	Elazig	Kalecik	1974	39	13	I
	Gayt	Bingol	Gayt	1998	36	23	I
	Devegecidi	Diyarbakir	DevegeCidi	1972	33	202	I
	Dumluca	Mardin	Bugur	1991	30	22	I
	Karkamis	Kahramanmaras	Firat	2000	29	157	H
	Cip	Elazig	Cip	1965	23	7	I
	Palandoken	Erzurum	GedikCayiri	1997	19	1 558	I
	Porsuk	Erzurum	Masat	1994	17	770	I
					Total	**99 598**	
Syrian Arab Republic							
	Al Tabka	At Thawrah	Euphrates	-	-	11 200	
					Total	**11 200**	
Iraq							
	Mosul	Mosul	Tigris	1983	131	12 500	I
	Derbendi Khan	Ba'qubah	Diyola river	1962	128	3 000	I
	Dokan		Lesser Zab	1961	116	6 800	I
	Haditha	Haditha	Euphrates	1984	57	8 200	I, H
	Hamrin	Ba'qubah	Diyola river	1980	40	4 000	
	Dibbis		Lesser Zab	1965	15	3 000	I
	Samarra - Tharthar	Samarra	Tigris	1954	-	72 800	F
					Total	**110 300**	
Iran (Islamic Republic of)							
	Karoun 3	Eizeh	Karoun	2004	205	2 970	I, H
	Dez	Andimeshk	Dez	1962	203	2 856	I, H, W
	Karoun 1	Masjedsoleyman	Karoun	1976	200	3 139	I, H
	Masjedsoleyman	Masjedsoleyman	Karoun	2001	177	230	I, H
	Gavoshan	Kamyaran	Gaveh roud	-	136	550	I, H, W
	Karkheh	Andimeshk	Karkheh	2001	127	5 575	I, H, F
	Vahdat	Sanandaj	Gheshlagh	-	80	224	I, H, W
	Eilam	Eilam	Baraftab & Chaviz	-	65	71	I, W
	Guilangharb	Guilangharb	Guilangharb	-	51	17	I
	Shahghasem	Yasouj	Parikedoun	1996	49	9	I
	Hana	Samirom	Hana	1996	36	48	I
	Bane	Bane	Banechay	-	20	4	W
	Chaghakhor	Boldaji	Aghbolagh	1992	13	42	I
	Zarivar	Marivan	Zarivar	-	11	97	I
					Total	**15 832**	
					TOTAL	**236 930**	

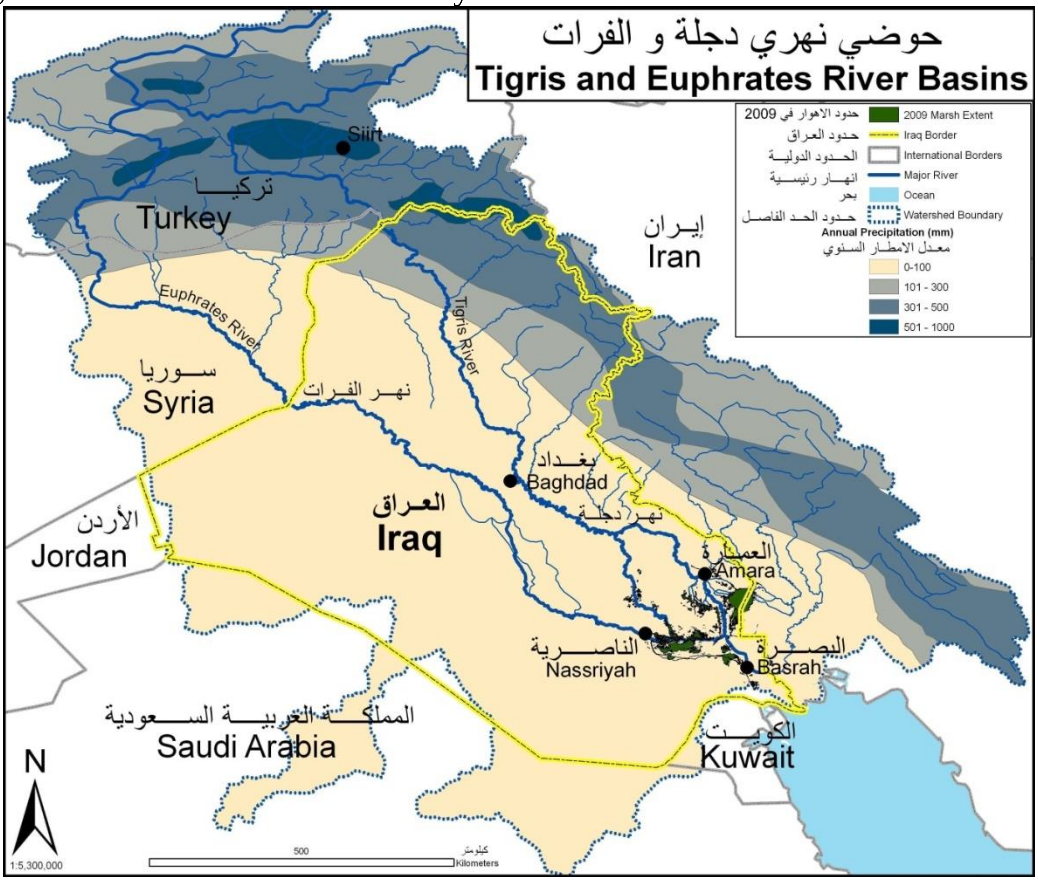
* I = irrigation; H = Hydropower, W = Water Supply; F = Flood protection

Table (2) Dams of the River Euphrates in Syria.[12]

Dam	Storage Capacity (km^3)	Year of Operation
Forat	14.163	1978
Baath	0.09	1989
Teshreen	1.883	2000
Total	16.135	

Second: Most Euphrates–Tigris River Basin has a sub-tropical Mediterranean climate with wet winters and dry summers. In the mountainous headwater areas, freezing temperatures prevail in winter and much of the precipitation falls in the form of snow. As the snow melts in spring, the rivers rise, augmented by seasonal rainfall which reaches its maximum between March and May. In southeastern Turkey and the north of the Syrian Arab Republic and Iraq, the climate is characterized by rainy winters and dry, warm summers. Average annual precipitation in the Euphrates–Tigris River Basin is estimated at 335 mm, although it varies all along the basin area

[18]. In the Mesopotamian Plain, the annual rainfall is rarely above 200 mm, while it reaches 1045 mm in other places in the basin fig.(6).



Fig(6)Tigris and Euphrates river basins [annual precipitation][26]

The summer season is exceedingly hot and dry, with midday temperatures approaching 50 ºC and with daytime relative humidity as low as 15 percent. These climatic conditions demonstrate that both the Euphrates and the Tigris flow through semi-arid and arid regions within the Syrian Arab Republic and Iraq [14]

The Arab region is therefore considered among the world's most vulnerable regions to the adverse impacts of climate change; it will be especially exposed to diminished agricultural productivity, higher likelihood of drought and heatwaves, long-term dwindling of water supplies, loss of low-lying coastal areas, and considerable implications on human settlements and socioeconomic systems (IPCC, 2007) [19]. Figure. (7) demonstrated the location of Turkey in semi-arid where Syria and Iraq in the Arid Zone.

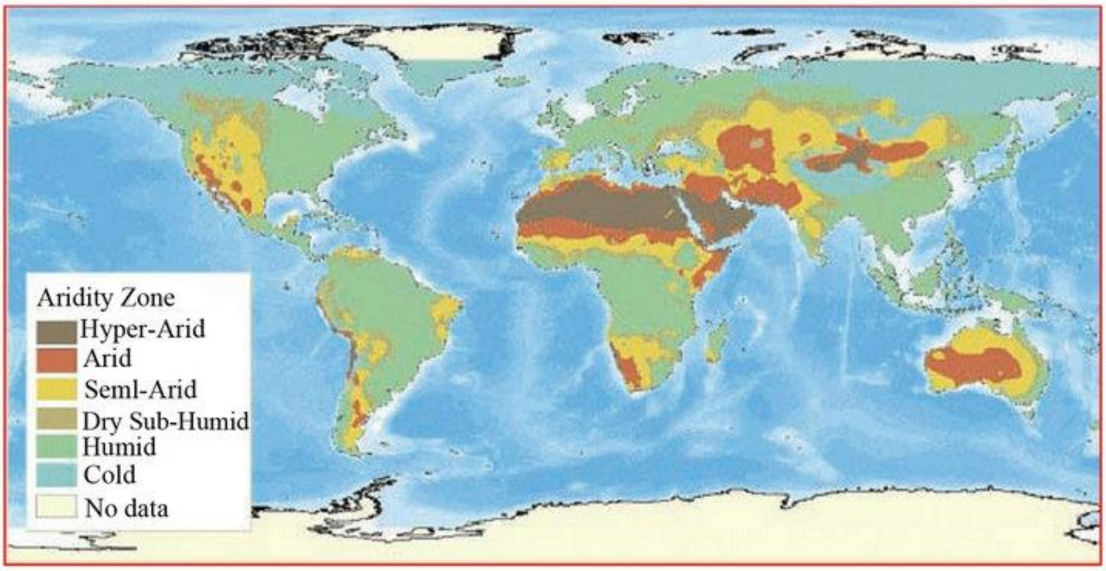


Fig.(7) Aridity zones of the world[22]

The study by Al-Ansari [12] shows that the overall average evaporation and evapotranspiration are of the order of 1900 mm per year Fig. (8).

Considerable variability in the climate, upstream supply and domestic use have caused Iraq's hydrological system to undergo dramatic change over the past 30 years [20].

The factors mentioned above lead to a shortage of perennial surface water and mean that reservoirs, lakes, and rivers are diminished to critical levels. Water levels in the Tigris and Euphrates rivers, Iraq's primary sources ofsurface water, have fallen to less than a third of their normal capacity.[20] Fig. (9) shows that Turkey, Syria and Iraq are all experiencing dramatic decrease in the total amount of renewable water resources available per capita. These factors are regarded as the main reason for the degradation of SAR water quality.

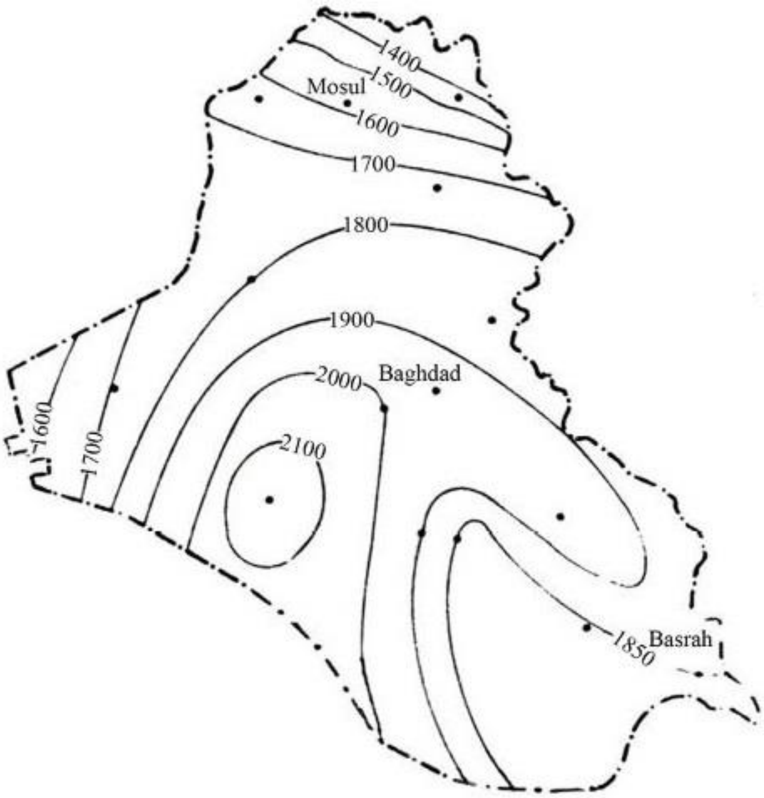
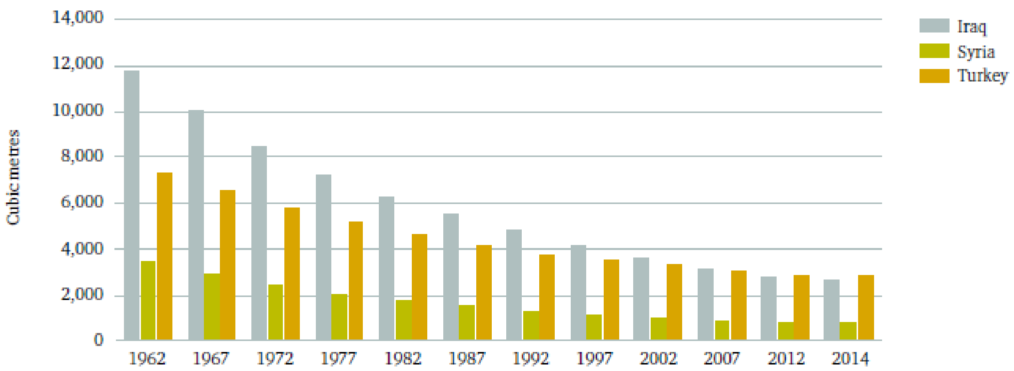


Fig.(8). Average annual evaporation(mm) [12]



Source: AQUASTAT[15] and author's estimates.

Figure 9: Renewable water resources available per capita, 1962–2014[4]

Expected future of SAR Sources

In the future, Iraq is facing water shortage problems due to projected climate change
At the end of the century, the mean temperatures in the Middle East and North African countries (MENA region) are projected to increase by 3˚C to 5˚C, while the precipitation will decrease by about 20% [45]. Water run-off will be reduced by 20% to 30% in most MENA by 2050 [21], and water supply might be reduced by 10% or greater by 2050 [46]. The weather events will include more droughts and floods. In a previous paper (12), The Third Generation Coupled Global Climate Model (CGCM3.1) (T47) model with the A2 scenario was chosen in order to simulate the average monthly temperature and rainfall on Iraq for the historical period 1900-2009, and for mean future projected temperature and rainfall until 2099 [47]. The results are shown

in Figures 10 and 11. A comparison of temperatures (Fig. 10) shows that the increase in annual temperature was limited from (1900-2009), but the increase was more noticeable during 2020-2099. Figure (11) shows the average annual rainfall is increased till 1960 then decrease up to 2009 and expected to increase again until 2039 followed by a decrease by 2099.[12]

As mentioned before, Turkey's location in a semi-Arid zone, Syria and Iraq in the Arid zone (Fig.7). So, they are considered as part of drylands. Although the significance of future global warming for dryland climates cannot be assessed with confidence, predictions based on general circulation models suggest temperatures will rise in all dryland regions in all seasons. Predicted increases in temperature are expected to increase potential evapotranspiration rates in drylands and, without large increases in precipitation, many drylands could become more arid in the coming century.

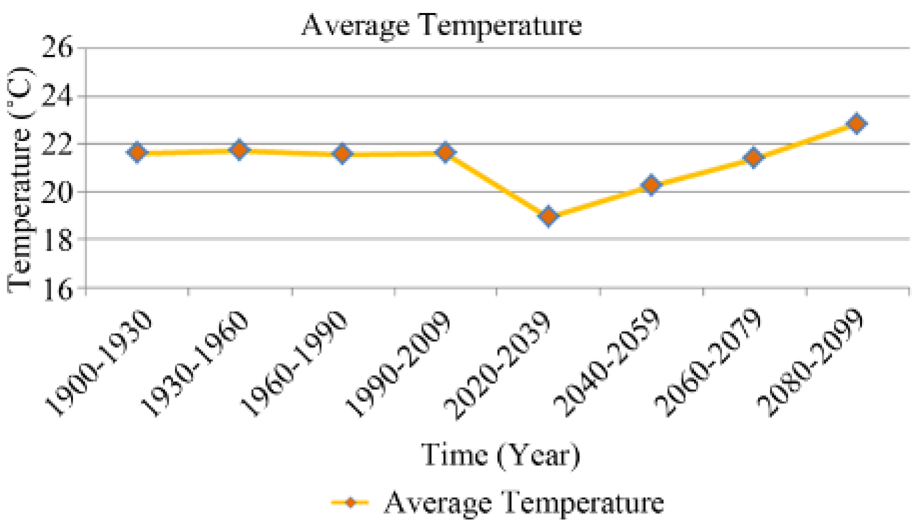


Fig.(10) Average annual temperature over the historical and future study periods.[12]

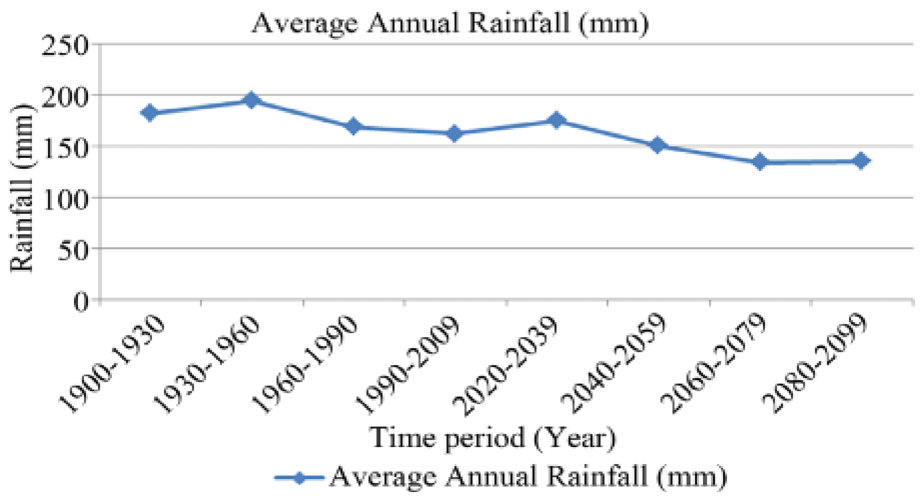


Fig.11) Average annual rainfall over the study historical and future periods.[12]

Two indicators are used to evaluate freshwater resources' status; these include water stress and water scarcity. Figure (12) shows the projected water supply in major watersheds in drylands for the year 2025. Many basins appear to have sufficient water for the population of that basin in 2025 [22]. For other basins, including (the Euphrates and Tigris basin), these indicators suggest that water supply problems will occur in the near future. In addition to climate change, all three countries Turkey, Syria, and Iraq plan further large-scale water resources development for agricultural irrigation, energy, and industrial and municipal uses in the coming decade.

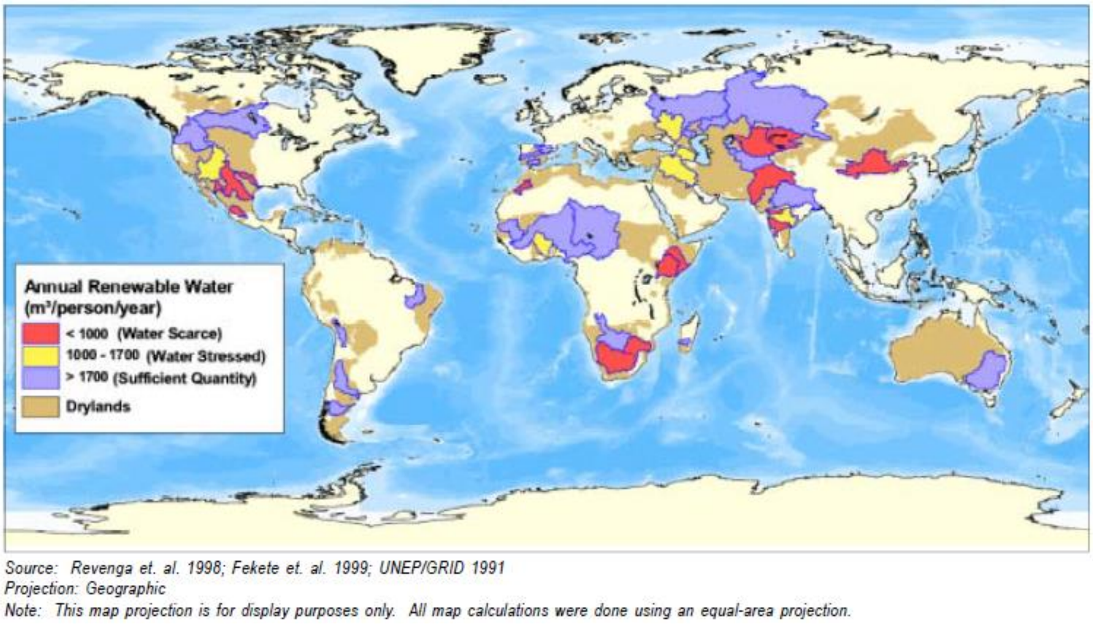


Fig.(12) Projected Water Supply in Major Watersheds in Drylands, 2025[22]

This will add pressure to areas and communities that are already water-stressed. The upstream development contributes to water depletion. Figure (13) illustrates the water depletion through time and when full upstream development has taken place.[23] In Turkey, GAP was intended for completion in 2023, but a number of projects have been put on hold or delayed and the target year has been changed to 2047. The government expects annual water demand to rise from 50 billion cubic meters (m^3) in 2012 to 112 billion m^3 in 2023.[24] The ambitious scale of the GAP reflects Turkey's formidable projected water needs. Turkey has a significant capacity to control downstream river flow. Turkey has an estimated 90 billion m^3 of water-storage capacity. This means that the country can, in theory, prevent all flow of the Euphrates from entering Syria for two to three years (based on average yearly flows).[4]

In brief, the construction of dams on the Tigris and Euphrates and their tributaries outside the border of Iraq, the effect of global climate change, and water resources mismanagement are the main factors in the water shortage problems in Iraq [25]. At current rates, Iraq's water supply will fall to an estimated 43 km^3 by 2015, far short of the 77 km^3 that the country will need to avert the desertification of 1.5 million hectares of agricultural lands and a widespread humanitarian crisis.[29] According to a UNESCO- US Government model, the outlook for annual surface water supply from 2010 to 2047 shows severe shortages for Iraqi agriculture (18 km^3/year), the Marshlands (26 km^3/year) municipal and industrial use.[30] An international report recently warned that the Tigris and Euphrates rivers could completely dry up by 2040.[31]

The accelerating decline of water supplies and increasing demand threaten to bring

Iraq closer to the water poverty threshold (1,000 m^3 per capita).[26]

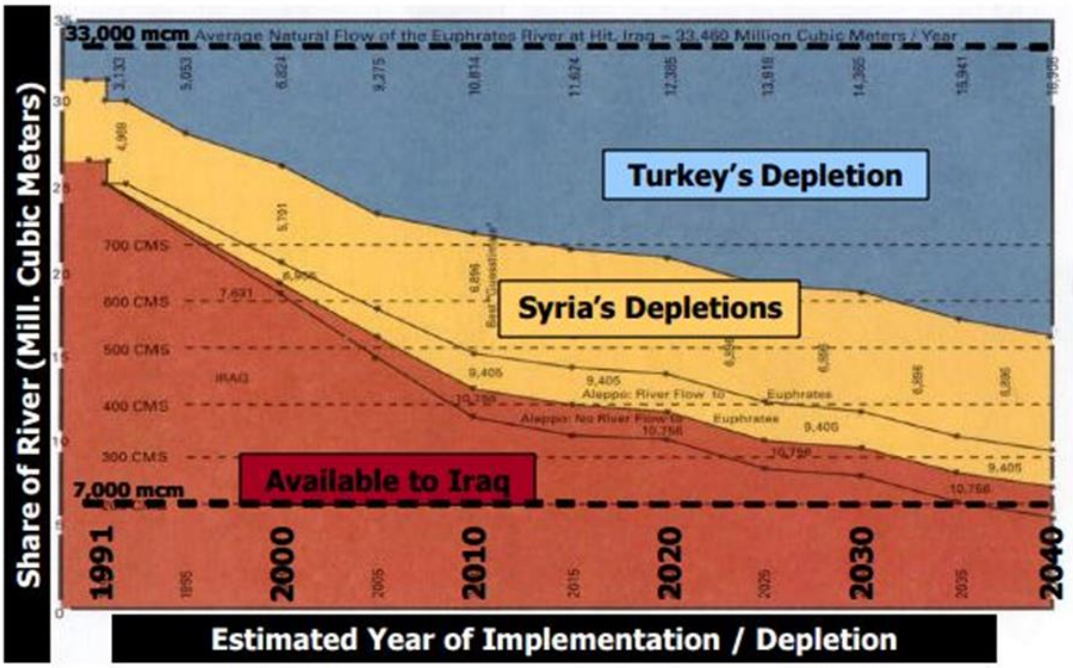


Fig.(13) Depletion of water from Euphrates [24]

Quality of SAR water

Water quality in SAR is fluctuated from time to time depending on **first:** discharge from the sources. Tigris in Al Kassarah Dam is currently regarded the main source. Figure (14) shows the daily discharge for 2014 and 2015(the source of data is the Water Resources Directorate in Basra). During 2014, two maximum values were only recoded on 12 Feb. (91.73 ms^{-1}) and 18 May (92.77 ms^{-1}). Otherwise, the trend extended from 72.2ms^{-1} on 17 Jan to 36.1ms^{-1} on 13 Dec. In 2015 for five months (Jan. to May), the discharge ranged from max. value (47.77) and min. value (25.57). The discharge values were low and not sufficient to prevent the salty front progress with the tidal wave farther to the upstream. **Second:** The tidal force from the Arabian gulf is affected by the prevailing wind direction. Northerly or Northwesterly wind tends to keep the tide dribble; south or southeasterly wind has the opposite effect and being also affected by the monthly rhythm of spring and neap tides. Results presented by (Abdullah et al., 2015) [1] confirm the substantial variations in the salinity levels and the SAR. Figure (15) shows the average salinity concentration for 10 stations along the SAR during February 2014, The salinity levels at the monitoring stations ranged from 900 ppm of Tigris water (just upstream of the SAR) to 10,000 at Faw (near the SAR estuary).[1]

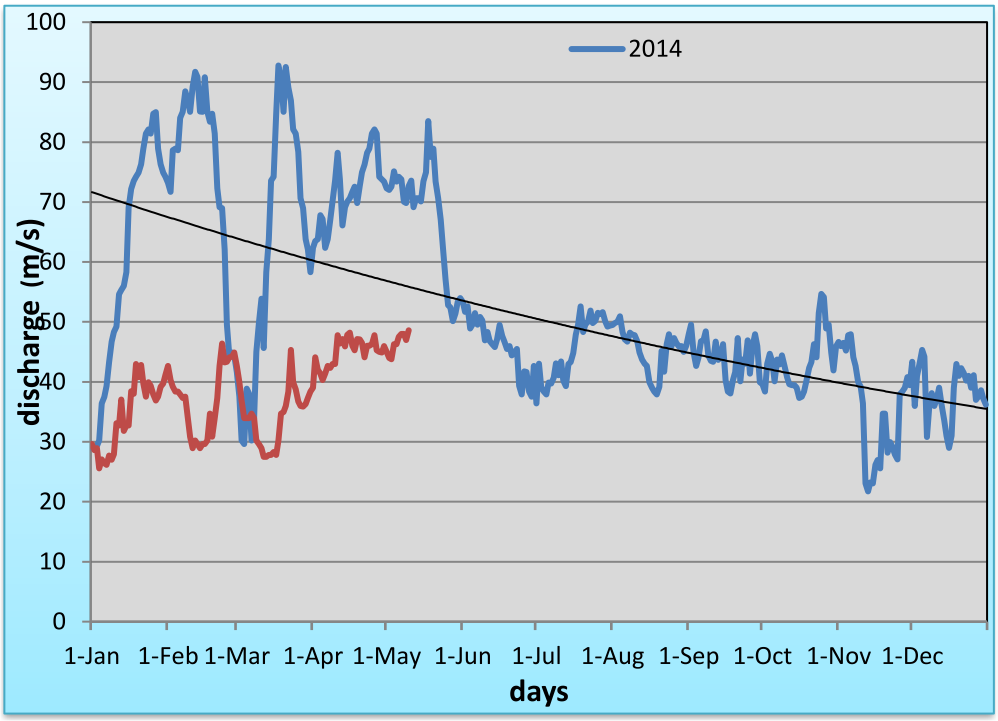
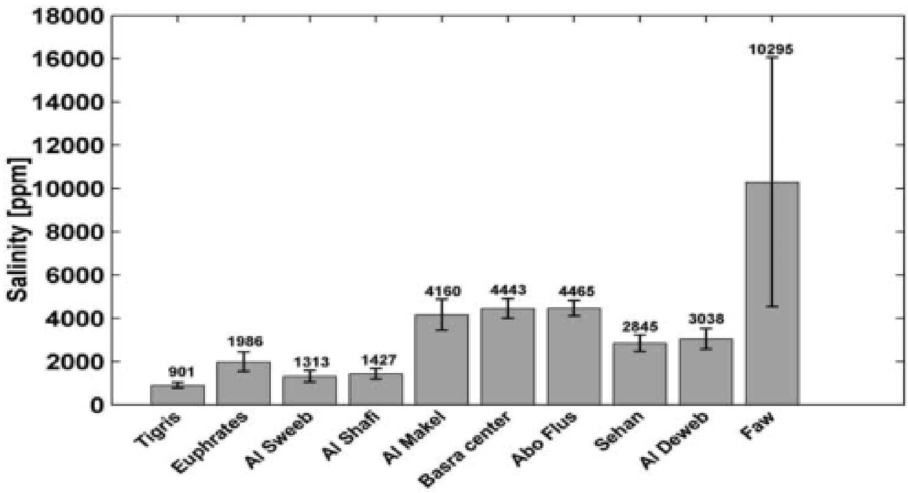


Fig.(14)Daily discharge in the Al kassarha dam in Missan for 2014, 2015



Fig(15) average salinity concentration for 10 stations along the SAR during February 2014 [1]

Figures (16,17,18,19) show the monitoring of hourly variation of salinity at stations located along with SAR. table (3) for 2014, all data were taken from the Marine Science Center in Basra City. All stations show that the salinity concentration in the SAR is not stable and variable from hour to hour; this variation is very fast with time and place and reflects the effect of all factors discussed in this paper. Water with such salt concentration is not suitable for drinking, irrigation, and other purposes. The results presented in this paper clearly show a significant increase in salinity over time and from upstream to downstream of the SAR. A decline in quantity and quality of freshwater from the sources due to increased withdrawals and consumptions is regarded as the major reason.

Table (3) location of monitoring station on ASR

Station Name	Latitude	Longitude
Tigris	$31^{0}.41$	47.26
Makel	30.49	47.46
Abo Flus	30.27	48.01
Sehan	30.19	48.11

Expected future of SAR

As noted from the figures, salinity concentration increases with time. As long as the SAR sources go on water shortage or could completely dry up by 2040; Water of SAR will turn into seawater from the Arabian Gulf the tidal wave. We must seriously think from now how to solve this problem to sustain agriculture and provide water for drinking to the province of Basra.

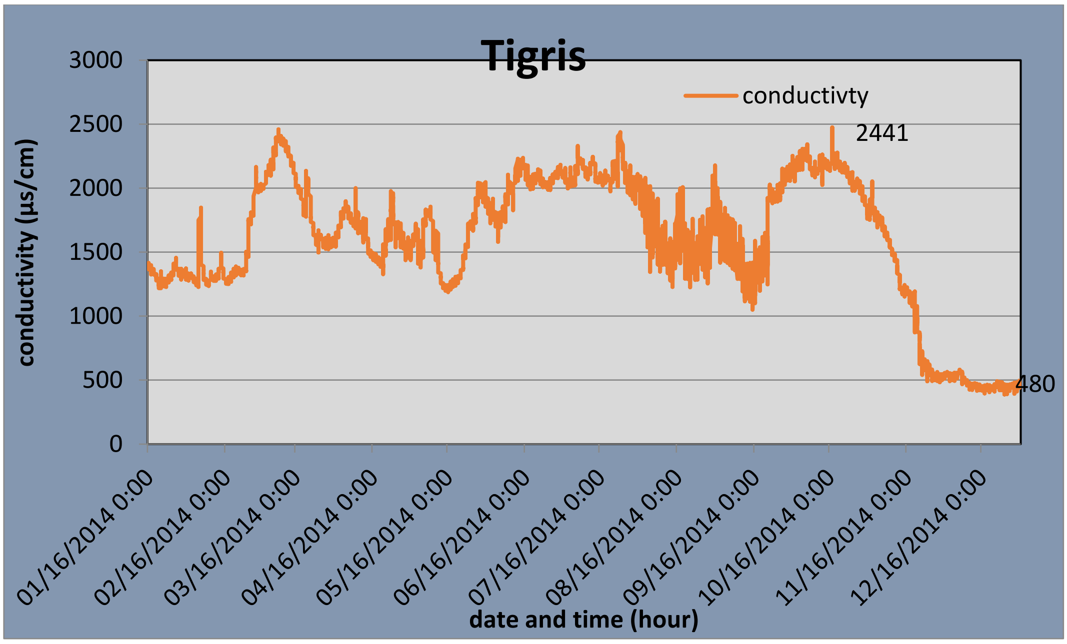


Fig.(16) Tigris station monitoring hourly variation of salinity for the year 2014

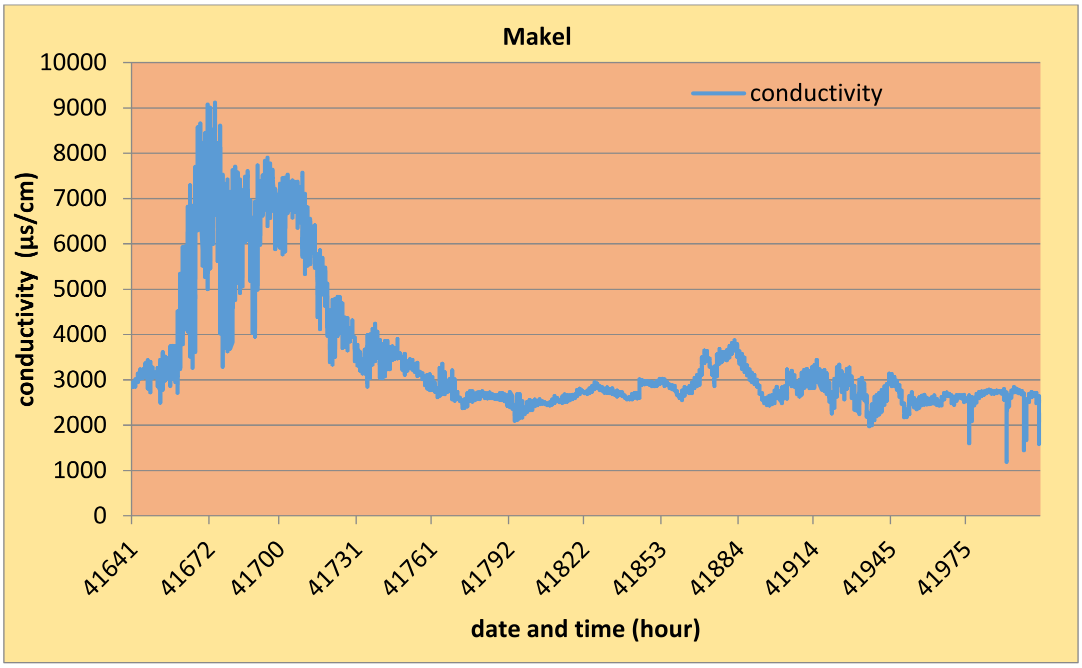


Fig.(17) **Makel** station monitoring hourly variation of salinity for the year 2014

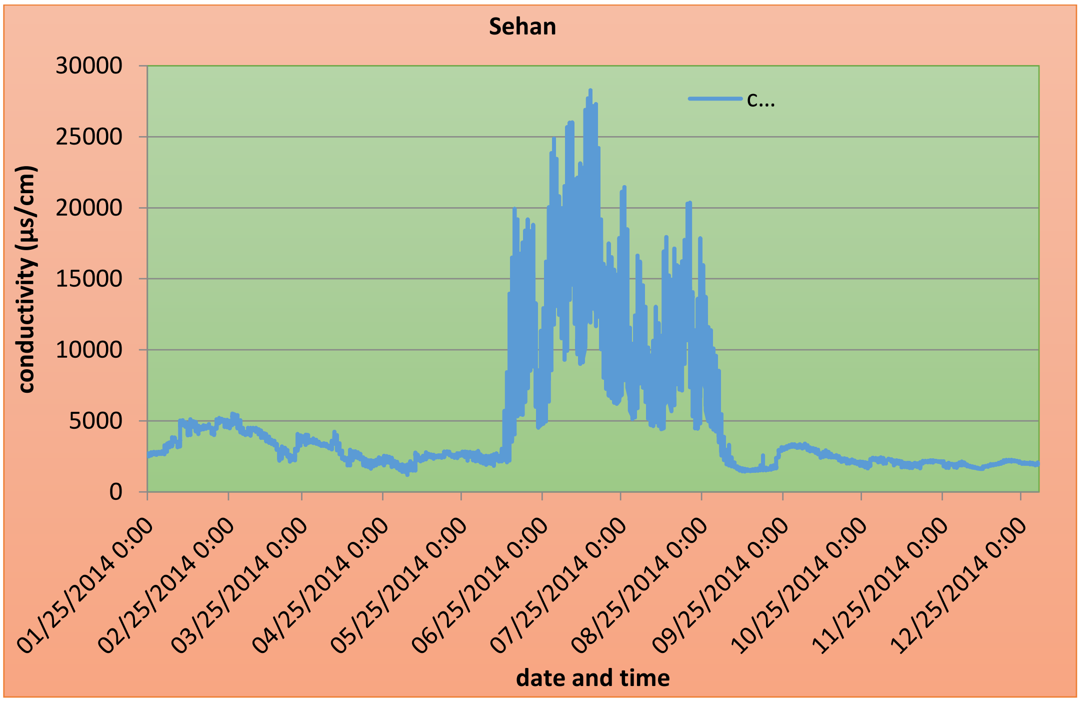


Fig.(18) Sehan station monitoring hourly variation of salinity for the year 2014

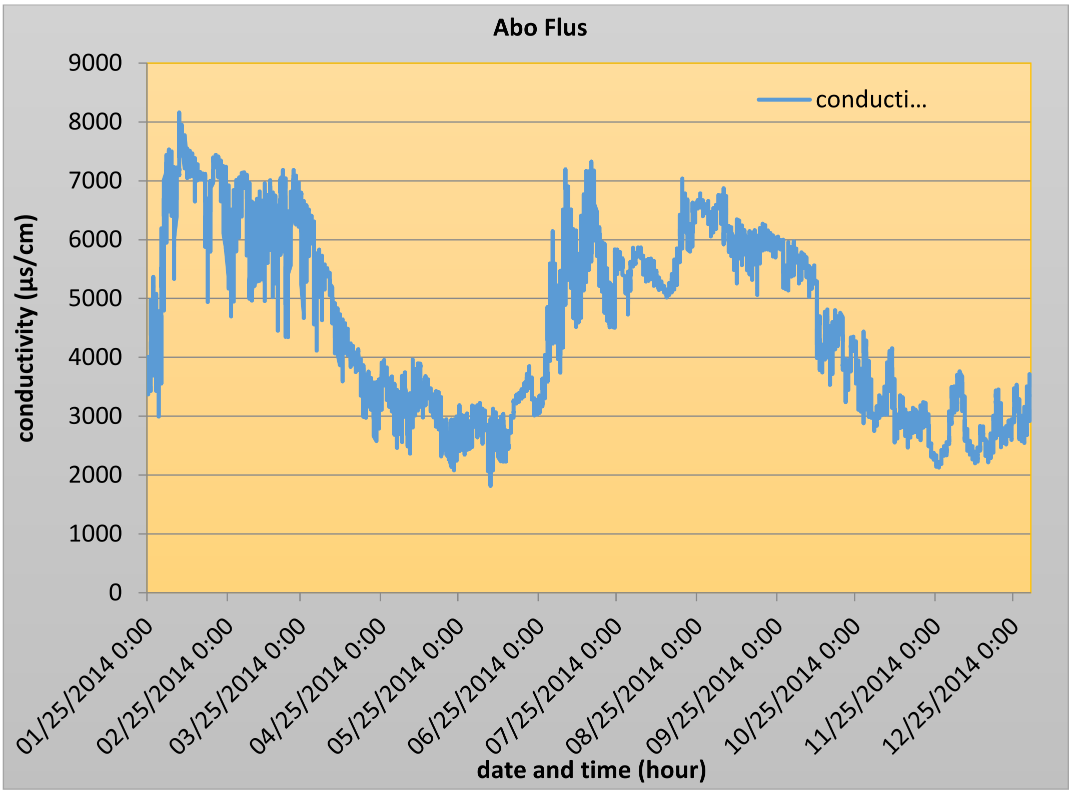


Fig.(19) Abo Flus station monitoring hourly variation of salinity for the year 2014

Conclusion

Shatt Al-Arab River is regarded as the main source of surface water in Basra governorate; its water is used for various purposes; drinking, irrigation, fisheries, navigation, and industry. **SAR** forms at Qurna where the Tigris and Euphrates Rivers join together; it is a conjunction of freshwater from Iraq into the Arabian Gulf. Two Factors cause the problem to Iraqi water sources, the first includes human interference, population, agriculture, infrastructure and dams. The Second is the natural factors which are summarized as climate change.

The construction of dams on the Tigris and Euphrates and their tributaries outside the border of Iraq, the effect of global climate change and mismanagement of water resources are the main factors of the water shortage problems in Iraq. According to a UNESCO- US Government model, the outlook for annual surface water supply from 2010 to 2047 shows severe shortages for Iraqi agriculture (18 km^3/year), the Marshlands (26 km^3/year) as for municipal and industrial use. An international report recently warned that the Tigris and Euphrates rivers could completely dry up by 2040.

Water quality in SAR is fluctuated from time to time depending on **first:** discharge from Tigris in Al Kassarah Dam and **second:** on the tidal force from the Arabian gulf which is affected by the prevailing wind direction. The monitoring of hourly variation of salinity at stations located along SAR. show that the situation of the salinity concentration in the SAR is not stable and variable from hour to hour, this variation is very fast with time and place and reflects the effect of factors discussed in this paper.

The results presented in this paper clearly show a significant increase of salinity over time and from upstream to downstream of the SAR. Decline in quantity and quality of freshwater from the sources due to increased withdrawals and consumptions is regarded as the major reason for this problem. and a further reduction in fresh water levels would, even more, increase the salinity levels in the SAE

It is noted from the figures; salinity concentration increases with time and, as long as the sources of SAR go on water shortage or completely dry up by 2040; water of SAR will turn into seawater coming from the Arabian Gulf with the tidal wave. So that, we must seriously think from now to solve this problem, through applying the following recommendations: 1- The establishment of a giant desalination plant, 2-Wastewater Treatment and Reclamation Plant, 3-Dam construction, 4-Activating the irrigation Ktiban channel, to sustain agriculture and provide water for drinking to the province of Basra.

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التحديات التي تواجه شط العرب حاضرا ومستقبلا

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المستخلص

يعد شط العرب واحدا من الانهر الرئيسية والمهمة في العراق ، كما يعتبر المصدر الرئيسي للمياه السطحية في محافظة البصرة. وتستخدم مياهه في مختلف الاغراض ، للشرب والري والصناعة والنقل وصيد الاسماك.

يتكون نهر شط العرب من التقاء نهري دجلة والفرات في القرنة وينقل المياه العذبة من العراق الى الخليج العربي . يتعرض نهر شط العرب لتزايد تراكيز الملوحة ، تعزى اسباب هذا التزايد الى اسباب محلية واخرى اقليمية: المحلية ناتجة من زيادة تلوث المياه والاقليمية ناتجة عن قلة تصريف المياه الواصلة لشط العرب. ان ازدياد تركيز الاملاح ينذر بكوارث بيئية.

في هذه الدراسة تم تناول العوامل التي تساهم في تغيير الخصائص الفزيائية للمياه من خلال تحليل بيانات مرصودة للاملاح وتصاريف المياه عند سد الكسارة كما تم تسليط الضوء على التحديات المستقبلية التي تواجه المصادر الرئيسية لنهري دجلة والفرات وتاثيرها على شط العرب.

يتضح من النتائج بان تركيز الاملاح في تزايد مع الزمن، سيؤدي الى تدهور نوعية وكمية المياه في شط العرب، ولكون مصادر مياه شط العرب الرئيسية ستتعرض الى نقص حاد في تصريفها او جفافها مستقبلا فان مياه شط العرب ستتحول الى مياه بحرية قادمة من الخليج العربي بتاثير المد والجزر.

كلمات مفتاحية: مستجمعات المياه، تحديات مستقبلية/ تملح، مياه عذبة، النظم البيئية